Chapter 3

Multiple-Functions Learning Control by Multiple Control Knowledge

Design of Learning Control with quality of multi-functionality produces functions with each function are based on specific control knowledge. Utilizing multiple control knowledge in a Learning Control System may provide flexibility in producing control commands, where relevant control function can be chose according to the requirement of the control environment. Design of a Learning Control System that applies multiple control knowledge may provide human like multi-functionality where human dependency can be reduced, resulting in semi-autonomous control device.

3.1 Multiple Control Knowledge in Learning Control

Human command plays major role in providing instruction for a device through series of control systems. Such command is based on human decisions in monitoring the surrounding environment, choosing an optimum option in providing reliable manoeuver to the control device. Complex control system such as devices with non-linearity produces more strain in the human decisions, requiring expert skills in producing command for a safe and reliable control. Applying a Learning Control System with multiple control knowledge can help decide a control decision to support an operation and can reduce the dependency on human command through application of multiple source of control knowledge in the system. Multiple source of control knowledge can be updated using Learning Control, providing expert control capable of replacing human commands.

Multiple source of control knowledge provides multiple options of functions in a control System that has potential to produce human like multi-functionality in a control operation. This is due to autonomous development of multiple control knowledge provided by the Learning Control System as shown in figure 3.1. Using multiple source of control knowledge, control strategy that applies both control knowledge can be produced, resulting in expert control of the control device. Here, the Learning Control System with multiple control knowledge can provide most of the control decision, reducing the control burden on human command.

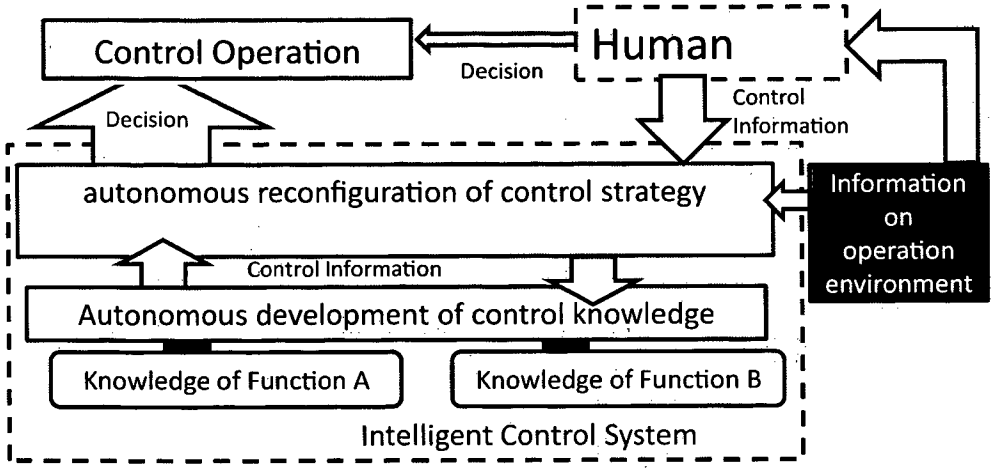

Figure 3.1: Structure of Learning Control System by multiple control knowledge.

Learning Control System by multiple control knowledge may reduce burden for controls on control devices with non-linearity. Control device as aerial hovering vehicle shown in figure 1.3 requires the operator to control the movement of the control device while maintain the stability of the device on air. Expert human operator is capable in manipulating those control parameters for rapid position transition of such device. Human multi-functionality provides commands on the angular orientation of the device using cyclic with assistant of thrust command that is also provided by the human. Based on the human multi-functionality, a Learning Control System with multiple source of Control Knowledge may provide Rapid Position Control by multiple Acceleration Control Functions in aerial hovering vehicle. Here, a Learning Control System by multiple source knowledge is design to provide rapid position control and rapid position control among obstacles for aerial hovering vehicle. The system is separated into two sections where the first section introduces the design of Learning Control System by multiple control knowledge for rapid position con-

trol, while the second section introduces the design of Learning Control System by multiple control knowledge for rapid position and obstacle control.

3.2 Application of Multiple Control Knowledge in Learning Control: Rapid Position Control

The first section of the Learning Control System by multiple control knowledge was designed for rapid position control of aerial hovering vehicles. Aerial hovering vehicles consist of non-linear parameters that require expertise in providing a quick reliable control. Here, human expertise in operating such device is generated through application of Learning Control System by multiple control knowledge.

3.2.1 Introduction to Rapid Position Control

Controls for aerial hovering vehicles involve manipulation of cyclic and thrust. Expert operator is able to operate the cyclic and thrust in providing safe position control for aerial hovering vehicle as shown in figure 1.3 through non-linear parameters within the device. Expert operator could even perform rapid position transition using cyclic and thrust along obstacle due to skills and experience in operating such device. Such skill is difficult to be operated by an autonomous control system. Here, Learning Control System by multiple control knowledge is designed to provide expertise in rapid position control for aerial hovering vehicles.

The system was developed for learning the best coordination of target angle θ_T that can perform a rapid position transition. Target angle θ_T provides changing in the direction of the thrust to create horizontal force that can create a horizontal movement while airborne. Figure 3.2 shows the changing in direction of the thrust according to target angle θ_T making the horizontal movement possible.

Configuration of the target angle θ_T requires increasing in thrust for providing lift force to preserve the leaning angle against gravity. When the preservation period of the leaning angle increased, the horizontal velocity of the aerial hovering vehicle will be increased due to changing of intensity in the horizontal force. Therefore, certain strategy concerning configuration of the target angle θ_T and its preservation period is needed for providing acceleration and deceleration for a precise position control.

Figure 3.3 shows the manipulation angular orientation of the aerial hovering vehicle during a position transition. A target angle θ_T^1 is configured to provide a horizontal force